Totally Laparoscopic Roux-en-Y Duct-to-Mucosa Pancreaticojejunostomy After Middle Pancreatectomy

A Consecutive Nine-case Series at a Single Institution

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Objective: To present the results of a series of laparoscopic middle pancreatectomies with roux-en-Y duct-to-mucosa pancreaticojejunostomy.

Summary of Background Data: Middle pancreatectomy makes it possible to preserve pancreatic parenchyma in the resection of lesions that traditionally have been treated by distal splenopancreatectomy or cephalic duodenopancreatectomy. The laparoscopic approach could minimize the invasiveness of the procedure and enhance the benefits of middle pancreatectomy.

Methods: From March 2005 to October 2007, 9 consecutive patients with benign or low malignant potential lesions in the pancreatic neck or body underwent surgery. Laparoscopic middle pancreatectomy with a roux-en-Y duct-to-mucosa pancreaticojejunostomy was planned on all of them. In the first 2 patients, the pancreas was transected by endostapler; in the last 7, the staple line was reinforced with absorbable polymer membrane.

Results: The intervention was concluded laparoscopically in every case except 1 (laparoscopic-assisted) in which pancreaticojejunostomy was performed by means of minilaparotomy. Mortality was 0% and perioperative morbidity was 33%, (fistula of the cephalic stump in the first 2 patients (22%)). The pancreaticojejunostomy fistula rate was 0%. The median postoperative hospital stay was 5 days (range, 3–41). In the last 7 patients, in which pancreas was transected with staple line reinforcement material there were no stump fistulas; morbidity decreased to 14% and the median hospital stay was 4 days (range, 3–30).

Conclusions: Laparoscopic middle pancreatectomy is feasible and safe. Duct-to-mucosa pancreaticojejunostomy can be performed safely using this approach. The method of pancreatic transection seems to be decisive in the incidence of cephalic stump fistulas.

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In the last decade, advances in pancreatic surgery have developed in 2 fundamental directions, both of which seek to minimize the aggressiveness of the procedures. On the one hand, techniques have been designed for partial pancreatic resection to preserve the spleen and as much pancreatic parenchyma as possible. The benefits of open middle pancreatectomy (MP) have been definitely stated in a recent revision[1] and in 2 series based on 40 and 100 patients, respectively.[2,3] On the other hand, laparoscopic approach, which has been slow to become generalized in the field of pancreatic surgery, is now in widespread use. The benefits of laparoscopy have been proven in different studies for distal pancreatectomies and enucleations.[4–6] As a result of both of these technical advances, we can now offer laparoscopic middle pancreatectomy (LMP) to patients with benign or low malignant potential tumors in the pancreatic neck or body and near the main pancreatic duct. One single 6-case series about LMP has been published with pancreatogastrostomy (PG) reconstruction in all cases.[7] We have found only 2 references in the literature about LMP with roux-en-Y duct-to-mucosa pancreaticojejunostomy (PJ), being one of them is our first case included in the Spanish National Registry of Laparoscopic Pancreatic Surgery.[8,9] The aim of this article was to describe our surgical technique for LMP with duct-to-mucosa PJ and report the results of our initial experience with 9 patients.

METHODS

Patients

From March 2005 to November 2007, 9 patients with benign or low malignant potential tumors in the pancreatic neck or body underwent surgery at our center. Computed tomography (CT) or magnetic resonance imaging and endoscopic ultrasound guided fine-needle aspiration biopsy complemented the ultrasound diagnosis. Mucinous cystic neoplasms and intraductal papillary mucinous neoplasms were managed according to the Sendai International Consensus Guidelines.[10] The advantages, disadvantages, and possible risks of the surgical procedure were explained to the patient and informed consent was obtained. Data were collected prospectively.

Surgical Technique

The patient is placed in supine position with legs apart; the surgeon stands between the legs. Pneumoperitoneum is created (CO_2 at 12 mm Hg) using an open technique to insert a Hasson

periumbilical trocar. A 3-chip digital camera (TRICAM SLII 20221140; Karl Storz, Tuttlingen, Germany) is used with 30 degree optics. After general examination of the abdominal cavity, the other trocars are inserted: two 12-mm working trocars level with the right and left midclavicular line, about 2 cm above the umbilicus. The first assistant then inserts a 5-mm trocar at the left anterior axillary line, and the second assistant inserts an 11-mm trocar below the right edge of the ribs (Fig. 1). A window is opened trough the gastrocolonic ligament for visualization of the lesser sac, taking care not to damage the gastroepiploic arcade. The gastric body is cranially retracted to expose the anterior face of the pancreatic neck, body, and tail. Once the existence of other lesions is ruled out, the tumor is located using a laparoscopic ultrasound probe (Philips HDI 5000, Bothell, WA, 5–9 MHz Laparoscopic Transducer) to establish its relation to the main pancreatic duct. The ultrasound control helps to mark the proximal and distal resection lines with a safety margin of 1 cm. With a hook, the peritoneum is released from the lower edge of the pancreas, exposing the superior mesenteric vein. A tunnel is opened behind the neck of the pancreas by blunt dissection and a cotton tape is placed around the gland (Fig. 2A). By pulling this tape upward, the pancreatic neck is dissected proximally and distally about 2 cm, easing insertion of an endostapler to perform the proximal pancreatic transection. In the first 2 patients, we used an endostapler (EndoGIA II 60-3.5, Auto Suture, Norwalk, CT) with 3.5-mm staples. In the last 7 patients, we used the same stapler but with 4.8-mm staples (EndoGIA II 60-4.8) and staple-line reinforcement (GORE SEAMGUARD Bioabsorbable Staple Line Reinforcement, W.L. Gore & Associates, Flagstaff, AZ) (Fig. 2B). In these cases, the trocar located in the left midclavicular line was replaced with a 15-mm trocar. To release the distal stump of the pancreas from the splenic artery and vein, small connecting vessels are sectioned between clips (Horizon, Endoscopic Ligating Clips, Weck; Teleflex, Limerick, PA) or with harmonic scalpel (Fig. 2C). This dissection is carried up to 2 cm far from the distal section line. Two sutures are placed on the upper and lower edges of the pancreatic section line. These stay sutures serves a hemostatic function and also they allow the pancreatic stump to be mobilized for pancreaticojejunostomy when pulled up properly by the first assistant. Next, the distal section of the specimen is performed with monopolar and harmonic scalpels, taking particular care to locate the Wirsung duct (Fig. 2D). Once the duct is identified, a 2-mm silastic tutor (06 French) is inserted. Pancreaticojejunal reconstruction is performed using a 50-cm retrocolic roux-en-Y jejunal loop. The anastomosis is a duct-to-mucosa pancreaticojejunostomy. A first line of sutures with 3/0 silk is placed with interrupted stitches between the antimesenteric edge of the jejunal serosa and the posterior side of the pancreatic capsule (Fig. 2E). After

opening a small orifice in the seromuscular layer with the hook (Fig. 2F), the mucosa is everted to prepare for duct-to-mucosa anastomosis. It is performed by placing 4 cardinal stitches of absorbable monofilament suture (Monocryl 6/0, C9260, Ethicon Products, Johnson & Johnson) between the everted mucosa and the main pancreatic duct (Fig. 2G). The last stitch secures the tutor before inserting it into the loop. This anastomosis is completed with another line of sutures between the anterior side of the pancreas and the jejunal serosa with interrupted sutures of 3/0 silk (Fig. 2H). Fibrin glue is placed around the pancreaticojejunostomy to protect the anastomosis. Finally, mechanical side-to-side jejunojejunostomy is performed with a stapler (EndoGIA II 60-2.5) and the mesenteric defect closed. The specimen is drawn into a bag (Endocatch, Auto Suture, Norwalk, CT) and removed through the umbilical incision, which does not have to be enlarged.

In all cases, amoxicillin/clavulanic acid was given for antibiotic prophylaxis; somatostatin analog (100 µg/8h subcutaneously for 7 days) was administered in order to prevent pancreatic fistulas.[11] Routine drainage was not used in any case, except for patient 3, after the experience of pancreatic fistula in the first 2 patients and for patient 9 in whom a partial gastrectomy was also performed. The nasogastric tube was removed at the end of the procedure and oral tolerance initiated on the first postoperative day. All patients were examined at the clinic after 1 and 6 months and then yearly.

RESULTS

The demographic and clinical characteristics of the patients are summarized in Table 1. Eight of the 9 patients were women. The mean age was 53 years (range, 28-60). In every case, the tumor was less than 3 mm from the duct, which contraindicated enucleation (Fig. 3). All the tumors were excised with both margins of at least 1 cm, as defined by intraoperative ultrasound study.

We treated 5 cystic tumors. In 3 patients, in which focal intraductal papillary mucinous neoplasms (patient 5), and mucinous cystic neoplasms (patients 7 and 8) were suspected before surgery, the definitive histologic diagnosis was serous cystic neoplasm.

Four neuroendocrine tumors were resected. All of them were small nonfunctioning neuroendocrine tumors and they were benign according to the definitive pathologic study: a fibrous connective tissue band surrounded tumors, mitotic rate was lower than 1 per 20 high power fields and no phenomena of vascular invasion were observed.

The data on the surgical aspects and results are shown in Table 2. In every case, the procedure was completed using the laparoscopic technique, except in case 2 in which the Wirsung duct could not be identified. Supraumbilical minilaparotomy (8–9 cm) was performed to identify the duct and PJ was completed as described. In all cases, the splenic vessels, artery and vein, were preserved. In patients 3 and 4, there was moderate inflammation distal to the tumor that made it difficult, but not impeded, to free the splenic vessels from the pancreatic body. These 2 patients required the longest operative times, exception made of the last case, in which a partial gastrectomy was performed due to a gastrointestinal stromal tumor. In every case, the pancreas under reconstruction had a normal duct (diameter approximately 2 mm) and its consistency was soft (except for patients 3 and 4).

An associated procedure was performed in 6 patients (66%): 5 cholecystectomies due to cholelithiasis and a partial gastrectomy due to a 1.3-cm gastrointestinal stromal tumor located in the posterior face of the lesser gastric curve. The mean operative time was 435 minutes (range, 357-509 minutes).

Blood loss was less than 100 mL in all patients. Patient 2 developed hemorrhage due to arterial bleeding of the cephalic stump on the first postoperative night. She required emergency laparotomy and the administration of 5 units of blood and 4 units of plasma.

Early surgical complications were observed in 3 patients. The first 2 patients of the series developed fistula of the cephalic stump and were treated satisfactorily by transgastric drainage and endoscopic sphincterotomy; in them, pancreas had been transected by endostapler without staple-line reinforcement or selective duct suture. The third surgical complication was observed in patient 4, who was released 6 days after the procedure, but returned on day 10 with fever and leukocytosis. An ultrasound study and CT revealed the existence of an abscess in the resection bed. After 7 days of antibiotic treatment with slow improvement, it was treated with endoscopic ultrasound puncture evacuating 20 mL of pus. No transgastric drain was left. Control US study was performed 4 days and 4 weeks after evacuation of this abscess and no residual collection was found.

Only patient 2 presented medical complications, with atelectasis and left pleural effusion on the chest x-ray that responded adequately to routine treatment.

At a median follow-up of 13 months (range, 2–34 months), all the patients are alive. We have not observed long-term complications other than a small umbilical hernia in patient 3 whose BMI was 35 kg/m^2, which was resolved surgically.

Six patients (66%) had no incidents following the procedure. The median postoperative stay for this group of patients was 4 days (range, 3–8).

DISCUSSION

Laparoscopic pancreatic surgery has undergone significant development in the last decade. However, almost all of the procedures carried out are enucleations and distal pancreatectomies. It has been claimed that, aside from these procedures, laparoscopic approach does not seem to provide any benefit in more complex procedures.[12]

We have appreciated the importance of preserving pancreatic parenchyma and have performed open MP since 1999.[13] Acquisition of skills in advanced laparoscopic surgery and laparoscopic distal pancreatectomies[14] has allowed us to offer our patients the benefits of MP with the advantages of the laparoscopic approach. The present series is, to our knowledge, the longest published to date for LMP. Our results indicate that LMP is feasible and safe.

The data from the main publications on MP, performed by open surgery, are shown in Table 3. This information includes 433 patients from a total of 20 series. Most of them are small and heterogeneous series, and only a few of them gather more than 15 patients.[2,3,15–18] These facts and the possible different selection criteria of the patients make it difficult to compare our results with those in Table 3. Nevertheless, it seems that the laparoscopic approach can offer advantages over the open approach in MP. The average morbidity of all the open published series is 41.58%, whereas in the present work it is 33%. Our median hospital stay (5 days) is the shortest of all the reports. During follow-up, we have not observed recurrent disease, pancreatitis, or endocrine or exocrine failure, which matches the findings in the literature for open MP.[1–3] Laparoscopic approach, then, could offer lesser perioperative morbidity, less blood loss, and shorter hospital stay with similar long term results.
Recently a 6-case series for LMP has been published in which a PG is performed in all patients.[7] PG is technically easier and faster, as just one anastomosis is needed, but at least in this experience, it also delays the oral feeding that was resumed in a median of 11 days.

Probably, this fact, and the use of abdominal drainage until day 10 could have contributed to prolong the length of stay (18 days, range, 15–25) losing one of the main advantages of the laparoscopic approach, as is the short hospital stay. On the other hand, PJ anastomosis is preferable to PG for long-term outcomes of pancreatic exocrine function after whipple resection.[19] Having on account that MP is indicated in patients with an expected long survival, we could consider that the best management for the distal pancreas is a PJ.

The mean intervention time for our series was 435 minutes. This reflects the demands of a precise and meticulous procedure, especially in the dissection of the splenic vessels and the

performance of the PJ. The presence of inflammatory reaction of the distal pancreas in 2 patients and the high rate of associated procedures prolonged even more the operative times. If we examine the last 2 patients without associated procedures (patients 6 and 7), the mean intervention time decreases to 372 minutes that is shorter, although still quite far from the reported times for open MP or LMP with PG (Table 3). Although a decrease of the operative times is expected with the experience, we cannot affirm to have observed it yet.

It is evident that LMP is a complex technique that entails a learning curve. One technical evolution that deserves special consideration is the method of transecting the pan-creas. In the first 2 patients, the pancreas was sectioned exclusively with a 3.5-mm endostapler. Fistula of the cephalic stump developed in these patients, resulting in the need for supplementary procedures and prolonged hospital stays. After this experience, we decided to use staple-line reinforcement with absorbable polymer membrane. Two recent studies report the efficacy of this reinforcement by reducing significantly the fistula rate after distal pancreatectomy when compared with standard stapling alone.[20,21] The results of these studies should be validated in a randomized controlled trial, but our experience in this series supports these preliminary results. Since we first used it, we have not observed any cephalic stump fistula: in the last 7 patients, the fistula rate (whether stump or anastomosis) was 0% and perioperative morbidity 14%. The median hospital stay for this group, in which this technical aspect was modified, was 4 days (range, 3–30).

Laparoscopic execution of the pancreatico-jejunal anastomosis has always been a major challenge because of its technical complexity.[12,22] In our series, there were no anastomotic fistulas even in soft pancreas with a nondilated duct. Several factors should be kept in mind for the successful laparoscopic execution of this anastomosis. The use of 3-chip optics is very helpful to achieve sufficient definition and image quality to identify a 2-mm Wirsung duct and suture safely with a 6/0-monofilament. We place a pediatric feeding tube for the duct-to-mucosa anastomosis. Although the use of stents to tutor the anastomosis has not demonstrated any clear benefits, it also is true that it does not result in major morbidity.[23] In our experience, the tutor facilitates the anastomosis procedure by keeping the duct patent. Another factor that may have had a favorable effect was not leaving aspiration drains. Some relevant studies state that patients with drains are more likely to develop an intra-abdominal abscess, collection, or fistula after pancreatic surgery.[24–26] The last but most important factor is that the surgical team should be experienced in both pancreatic and advanced laparoscopic surgery. At our center, the same team performs upper gastrointestinal laparoscopic surgery and hepatobiliary surgery.

In conclusion, the present series suggests that the laparoscopic approach in pancreatic surgery should not be restricted to distal pancreatectomy and enucleation. LMP has the same

benefits as open MP, with the additional advantages of the laparoscopic approach, and seems to decrease morbidity. Buttressing the staple line with absorbable material seems to be effective in preventing pancreatic fistula after distal pancreatectomy when compared with standard stapling alone; nevertheless, this as pect need to be confirmed by a randomized controlled trial. Duct-to-mucosa pancreaticojejunostomy can be performed successfully by laparoscopy and without leaks in the hands of surgeons experienced in pancreatic and advanced laparoscopic surgery.

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TABLE 1. Demographic and Clinical Characteristics of the Patients

Patient	Gender	Symptoms	Tests	Preoperative Diagnosis	Size (mm)	Final
1	F	Abdominal pain	US, MRI, EUS	SCN	25	SCN
2	F	Incidental	US, CT, EUS	NET	13	NET
3	F	Incidental	US, CT, EUS	NET	11	NET
4	F	Back pain	MRI, EUS	MCN	22	MCN
5	F	Back pain	US, CT, EUS	IPMN	13	SCN
6	F	Incidental	US, CT, EUS	NET	9	NET
7	F	Incidental, TG	US, CT, EUS	MCN	30	SCN
8	F	Incidental, TG	US, CT, EUS	MCN	30	SCN
9	M	Incidental	CT, octreoscan, EUS	NET	10	NET

US indicates ultrasonography; MRI, magnetic resonance imaging; EUS, endoultrasound (all cases with cytology); CT, computed tomography; SCN, serous cystic neoplasm; NET, neuroendocrine tumor; MCN, mucinous cystic neoplasm; IPMN, intraductal papillary mucinous neoplasm; TG, tumoral growth during follow-up.

TABLE 2. Surgical and Hospital Data

Patient	Surgical Procedure	Operative Time	Estimated Loss (mL)	Closure of Head Stump	Surgical	Treatment	Hospi Stay
1	LMP + LC	357	<50	Endostapler	Pancreaticfistula(head)	ERCP Transgastric	41
2	LAMP + LC	420	<50	Endostapler	Bleeding Pancreaticfistula(head)	Relaparotomy ERCP Transgastric drainage	23
3	LMP + LC	495	<100	Endostapler with	—	—	8
4	LMP	509	<100	Endostapler with	Abscess	Transgastric drainage	30
5	LMP+LC	458	<50	Endostapler with	—	—	5
6	LMP	359	<50	Endostapler with	—	—	3
7	LMP	386	<50	Endostapler with	—	—	4
8	LMP + LC	435	<50	Endostapler with	—	—	4
9	LMP + LPG	494	<100	Endostapler with	—	—	4

LMP indicates laparoscopic middle pancreatectomy; LAMP, laparoscopic-assisted middle pancreatectomy; LC, laparoscopic cholecystectomy; LPG, laparoscopic partial gastrectomy; SLR, staple-line reinforcement.

TABLE 3. Main Published Series of MP

Author	n	Open/L	Mean Operative	Anastomo	Estimated Blood	Pancreatic Fistula	Reoperati	Morbid	Mortal	Hospital Stay
Rotman et (1993)[27]	1	Open	—	PJ	—	14%	3%	29%	0	27.6 (mean) (9–120)
Ikeda et al (1995)[15]	2	Open	—	PJ	—	4%	0	13%	0	
Partensky et (1998)[28]	1	Open	—	PG	—	0	10%	40%	0	
Warshaw et (1998)[29]	1	Open	—	PJ	200	17%	0	25%	0	8 (median)
Iacono et al (1998)[30]	1	Open	250	PJ	—	15%	0	23.1%	0	9.6 (mean) (6–19 (mean) (10–
Sperti et al (2000)[31]	1	Open	273	PJ	440	30%	0	40%	0	26 (mean) (11–48)
Celis et al (2001)[32]	5	Open	336	PJ	200	0	0	0	0	<10 (median)
Molino et al (2001)[33]	4	Open	230	PJ	—	0	0	0	0	14 (median) (10–23)
Sauvanet et (2002)[16]	5	Open	—	PJ (49%) PG (47%) CPS (4%)	—	30%	5.6%	41%	2%	
Sugiyama et (2004)[34]	5	Open	—	PG	—	0	0	20%	0	
Goldstein et (2004)[35]	1	Open	226	PG	700	0	0	25%	0	6.5 (median) (5–15)
Efron et al (2004)[36]	1	Open	229	PG	412	36%	14.2%	50%	0	11.1 (mean) (±6.3)
Shibata et al (2004)[37]	1	Open	331	PJ	359	30%	0	50%	0	37 (19–49) 40 (mean)
Iacono et al (2005)[17]	2	Open	—	PJ	—	25%	0	35%	0	
Roggin et al (2006)[1]	1	Open	—	9 PJ 1 PG	—	30%	—	60%	0	
Muller et al (2006)[2]	4	Open	304	PJ	564	7.5%	5%	27.5%	2.5%	11 (median) (6–62)
Christein et (2006)[38]	8	Open	288	PJ	381	63%	25%	>63	0	15 (mean)
Johnson et (2006)[39]	8	Open	234	6 PG 2 PJ	321	0	0	37.5%	0	10.5 (mean) (9–13)
Bassi et al (2007)[18]	6	Open	—	—	—	51% A–C 21% B–C	0	>51	0	
Crippa et al (2007)[3]	1	Open	248 ± 60		311 ±	44%	0	58%	0	13 ± 9.5
SaCunha et (2007)[7]	6	Lap	225	PG	125	33%	0	33%	0	18 (median)
Present	9	Lap	435	PJ	<100	22%	22%	33%	0	5 (median)

PG indicates pancreaticogastrostomy; PJ, pancreaticojejunostomy; CPS, closure of pancreatic stump.

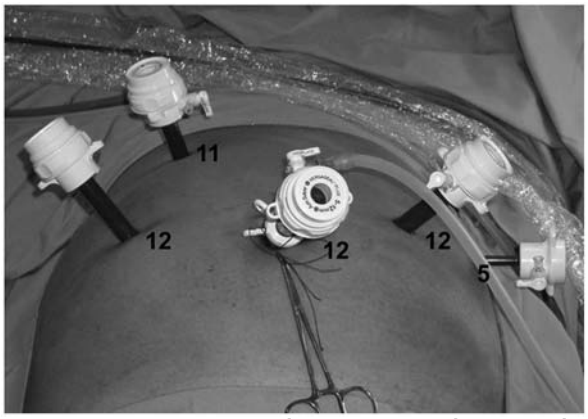

FIGURE 1. Trocar placement. The specimen is removed through the umbilical incision.

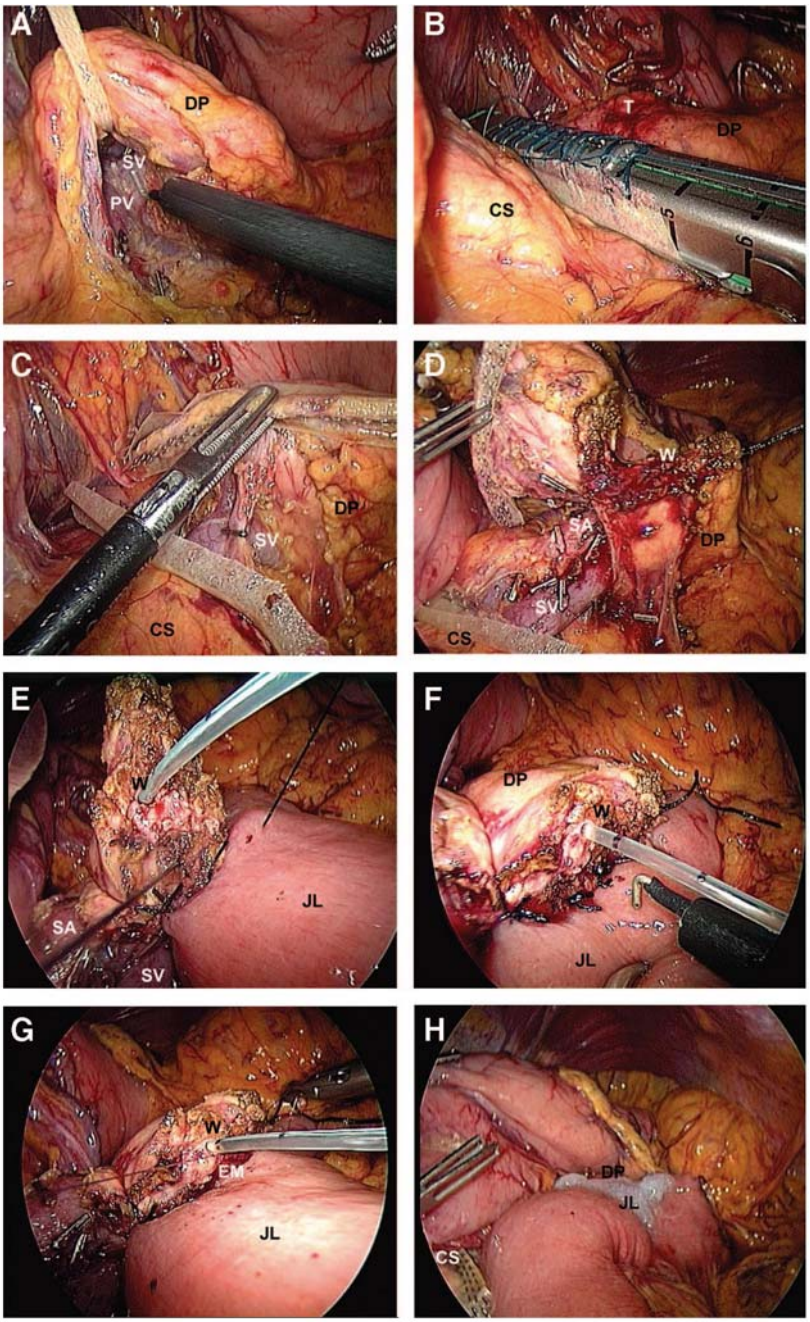

FIGURE 2. A–H, Steps of the surgical procedure as described in the text. A, a cotton tape around the pancreatic neck; B, transecting the pancreas with reinforced endostapler; C, releasing the distal pancreas from the splenic vessels; D, distal section of the specimen. E, suturing the jejunal serosa to the posterior capsule of the pancreas; F, opening a hole in the jejunal loop with the hook; G, tightening the first duct-to-mucosa stitch; H, final aspect of the surgical field. PV indicates portal vein; SV, splenic vein; DP, distal pancreas; CS, cephalic stump; T, tumor; SA, splenic artery; JL, jejunal loop; W, Wirsung duct; EM, everted mucosa.

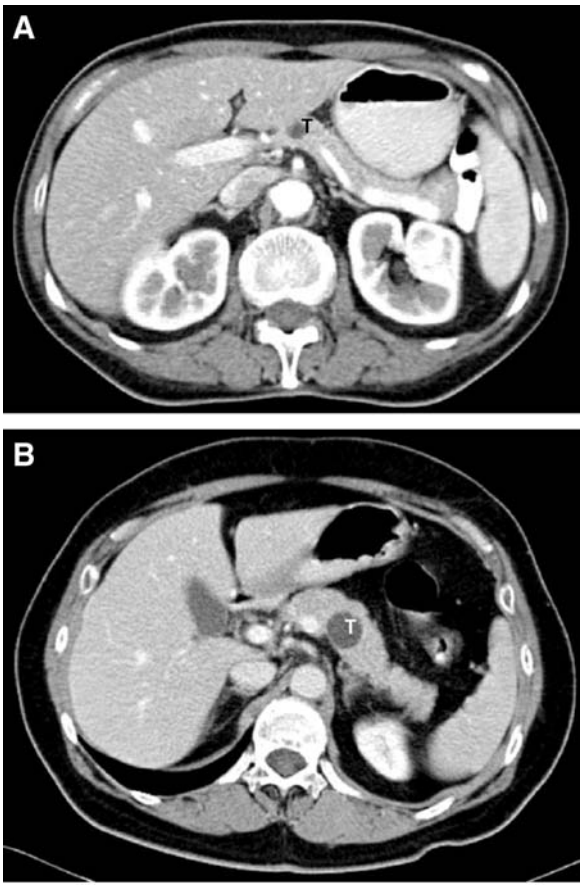

FIGURE 3. CT images of tumors located in the neck (A) and body (B). They belong respectively to patients 5 and 4. Tumors are indicated with T.